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ANNUAL REPORT 1972-73,
on
NASA GRANT 01-007-001,

"The Effect of Surface Conditions on the Work Function of
Insulators and Semiconductors".

Submitted to
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"The Effect of Surface Conditions on the Work Function of Insulators and semiconductors"

Abstract of Experimental Method

Ionization energies of organic semiconductors are determined using single crystals of the material. The theory of the method is essentially that of Millikan's oil drop experiment. The technique employed in the experiment is based on the electrostatic method of balancing a charged particle in an electric field against the force of gravity for different excitation energies above the threshold value, and from an estimate of the balancing voltages, read off the ionization energy from the intercept of the energy axis in a plot of $hc/e\lambda$ vs $\frac{1}{V}$, V corresponding to the balancing potential for the incident radiation of wavelength λ . In the new simple, modified technique which is adopted in the present experimental investigation, a small single crystal of approximately 25μ in thickness is suspended by a fine quartz fibre between two vertical capacitor plates to which a suitable high voltage is applied. The voltage helps to find a measure of the deflection produced in the crystal for each wavelength of the incident radiation. Depending on the charge of the crystal, the application of a suitable voltage in conjunction with the constant restoring force on the fibre, brings the crystal to a fixed balancing point in the field of view of a microscope. From a series of such balancing voltages for successive wavelengths of exciting U-V radiations, the ionization energy of the material is determined from the usual plot of energy vs reciprocal of balancing voltage.

Work done up to date

- I. Determination of ionization energies in air for a series of 8 organic materials, namely Anthracene, Graphite, Tetracene, Pentacene, Magnesium Phthalocyanine, CuPCN, ZnPCN and H₂PCN.
- II. Determination of ionization energies of Magnesium Phthalocyanine and Anthracene in vacuum of 10⁻⁶ Torr.
- III. Determination of ionization energies of Magnesium and Copper Phthalocyanines in a vacuum of 10⁻⁹ Torr.
- IV. Determination of ionization energies of Magnesium and Copper Phthalocyanines in oxygen and Hydrogen atmospheres.
- V. Determination of Ionization energies of Copper Phthalocyanines in nitrogen and carbon dioxide.

Experimental Lay Out

1. Central experimental chamber.

It is a perfectly vacuum sealed cross -tube with 6 limbs made entirely out of pyrex glass at the Research Institute of the University of Alabama, Huntsville, as reported in the previous reports.

2. Optical Unit.

Consists of a U-V grating monochro motor with a Deuterium lamp source.

3. Power Supply Unit.

A High voltage power supply giving an output of 0-6000 volts connected through a voltage divider to a digital voltmeter which gives readings of voltages to an accuracy of 1 volt.

4. Observation unit.

A telemicroscope with a glass scale.

5. Pumping unit.

Consists of

- (a) Two stage mechanical pump

- (b) Coaxial foreline traps & valves.
- (c) Mercury diffusion pump with liquid nitrogen cold trap.
- (d) Backing thermo couple gauges.
- (e) Ionization gauge.
- (f) Grease free float valves which are magnet controlled.

6. Gas inlet system

Consists of

- (a) Gas tanks with suitable regulators
- (b) Discharge and thermo couple gauges
- (c) Leak valve for letting in gas
- (d) An ion pump for exhausting the unit separately which is initially backed by a mechanical pump with foreline traps and high vacuum valves in the line.

Publications ~~(Copies Attached)~~

- (1) "An Electrostatic suspension method for determining photo ionization energies of solids"

Physics Letters, Vol. 44A, No 1, (9-10), May, 1973.

- (2) Photoionization of Magnesium and Copper Phthalocyanines in Oxygen and Hydrogen.

Journal of Applied Physics, November, 1973)
(To appear in the November issue)

Papers Presented

1. A paper entitled "Effect of adsorption of Oxygen and Hydrogen on the surface structure of Magnesium and Copper Phthalocyanines was presented at the American Physical Society spring meeting in Washington, D.C. in April, 1973.
2. Two papers on ionization energies of the different organic semiconductors were presented at the Alabama Academy of Sciences held at Huntsville in April, '73.

Student Assistants

Mr. William F. Scott has worked with the program during the course of the year and for about 2 months in the summer of '73.

Expenditure up to Sept. 1, '73

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| 1. | Equipment
Replacement etc. | \$ 450 |
| 2. | Personnel | |
| | Principal Investigator | \$8,300 |
| | Student Assistant | \$2,400 |
| | Technical Assistance | \$ 240 |
| 3. | Travel | \$ 900 |
| 4. | Office supplies, phone, typing etc. | \$ 350 |